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more inclusive this value is, the fewer tendencies are left outside which might oppose its complete realization of itself. If it were all-inclusive, there would be nothing left to prevent its passing from potentiality to actuality. A perfect value, or a perfect being, consequently, must be actual—as the ontological proof said. But the question remains, is there any empirical evidence of such an all-inclusive or perfect value, even as merely potential? Does the ideal of perfection show itself as a real tendency, working in experience? Religious people claim that it does so, in their own personal experience. It is outside our province to discuss this question. But it is, I think, a wholly empirical one. The definition of value obtained above would seem to show that if such an ideal is verifiable as a working tendency in our lives, the ontological proof would hold. Kant's refutation of that proof was based on the assumption, inherited from Descartes, of a gulf fixed between subject and object, value and fact. But our definition has crossed that gulf; or rather has shown that there is no gulf. Something of the fertility of the definition lies, I believe, in that closure of a long-established breach.

One more application of the definition may be made. At bottom, all reasoning, thinking, proving, knowing, is based upon certain principles which carry with them their own evidence. Such are the axioms of logic, the axiom that reality is accessible only in experience, etc. These are accepted because they are "deemed worthy." They alone make knowledge possible, and thus contribute to our desire for knowledge. They are to knowledge what God is to the religious devotee: they are all-inclusive cognitive values, grounding all particular judgments and their connections. Because they ground *all* knowledge, there is nothing to contradict them; their mere appearance guarantees their truth; they are, to us, methods of immediate insight. Their value is then more than potential, and they become truths. This is not the case with any less fundamental propositions, however useful they are; for the latter do not ground all knowledge, and some other propositions might contradict them. The fundamental axioms of all knowledge constitute a special case, like the perfect being, where value implies objective realization.

DARTMOUTH COLLEGE. W. H. SHELDON.

TWO FACTORS WHICH INFLUENCE ECONOMICAL LEARNING[1]

THE formation of a new habit—which is the process of learning—offers many problems to the experimental psychologist. Recently there has been considerable discussion as to the proper distribution of working periods in such formation. Such questions have been asked as, "How long should one work at any one period?" and, "How long an interval of time should intervene between successive periods?" That is, what is the relative value of short periods of work as compared with longer periods? And again, what is the value of short intervals between working periods as compared with longer intervals?

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[1] Read before the Atlanta meeting of the American Association for the Advancement of Science, in Section H. (One correction due to information more recently supplied me by letter has been made with reference to Pyle's work.)

These questions have not only been asked, but already answered, at least in part. The experimental investigations of Ebbinghaus,[2] Yost,[3] Dearborn,[4] Starch,[5] and Pyle[6] all agree in the main that short working periods are superior to longer periods, and that intervals of a day are superior to longer or shorter intervals. But just how much more efficient certain periods are than others has not been worked out with anything like the accuracy that we need. And more important still, we do not know, except in a very general way, what the factors are which go to cause the results so far obtained.

I am interested in these same questions, but from an entirely different standpoint from that of the above-mentioned experimenters. And though my work has been rather more concrete than theirs, I have arrived at conclusions absolutely confirmatory of this previous work. I have been endeavoring for some time to determine how different intervals of time between presentations of a firm's advertisements affect the final permanent impression. My special problem has been to determine the relative effects produced upon a reader, (*a*) when four advertisements of one firm are seen within a few minutes of each other, (*b*) when four advertisements are seen at intervals of one week, and (*c*) when four advertisements are seen at intervals of one month.

In systematizing my results I have used as a standard the average strength of a reader's retention of an advertisement four months after it was seen. This ability then is represented by 100. In Plate I. all my other measurements are shown in terms of this 100, and by it we can see how successive repetitions of advertisements affect permanence of impression. When the four advertisements are seen within a few minutes of each other the four create an impression that is 82 per cent. superior to that created by but one advertisement.

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[2] H. Ebbinghaus, "Gründzuge der Psychologie," Zweite Auflage, page 657.

[3] A. Yost, "Die Assoziationsfestigheit in ihrer Abhängigheit von der Verteilung der Wiederholungen." *Zeitsch. f. Psychol.*, 1897, 14, 436–472.

[4] W. F. Dearborn, "Experiments in Learning," *J. of Educ. Psychol.*, 1910, 1, page 373.

[5] D. Starch, "Periods of Work in Learning," *J. of Educ. Psychol.*, 1912, 3, pages 209–213.

[6] W. H. Pyle, "Economical Learning," *J. of Educ. Psychol.*, 1912–13, pages 148–158.

When the four advertisements are seen at intervals of a week the four create an impression 90 per cent. greater than did one. But when the interval is still further lengthened to one month the total impression from the four advertisements drops to only 45 per cent. more than from one advertisement.

Such a result is rather surprising when it is recalled that in the first case all the advertisements of a firm are seen fully four months before the test, in the second case the last advertisement of the firm is seen three months before the test, and in the last case the last advertisement is seen but one month before the test.

These figures indicate, then, that a firm's advertisements repeated at intervals of a few minutes or of a week create a very much greater permanent impression than they would if they were repeated at intervals of one month.

Thus far, I have secured no data concerning repetitions a day apart. All the work done on the subject, however, has been so strong in favor of the day interval, that I feel no hesitation in judging that I shall probably find it superior in my case.

But now there is another factor which influences learning, which enters into the general problem before us. How long should one work at one time in order to secure the greatest returns per minute spent? The workers on this question so far, with the exception of Pyle, have complicated their results by asking, for example, which is better: 2 repetitions a day for 12 days, or 4 repetitions a day for 6 days, or 8 repetitions a day for 3 days. Here two factors, "length of working period" and "the number of presentations," are involved. Pyle tells us that a 30- to 45-minute period is superior to a 15-minute or a 60-minute period. That is, if four individuals of equal ability work each day, respectively, 15, 30, 45, and 60 minutes, the second, by one calculation, and the third, by another, do the greatest amount of work. Pyle was presumably interested in the proper length of a recitation period and so gave his results in this way. But his data, as given, do not tell us how much work has been done by the four individuals if we consider the amount of time spent by them, minute per minute.

After simply reading his article I imagined that the 15-minute worker had probably accomplished more per minute than the other three workers. A recent letter has, however, made it clear that those who worked 30 minutes a day accomplished more per minute than those who worked 15 minutes a day, or those who worked longer periods than 30 minutes.

Now let me report some recent work of my own which, though it seems to have little in common with the just-mentioned investigations, touches intrinsically the same problem.

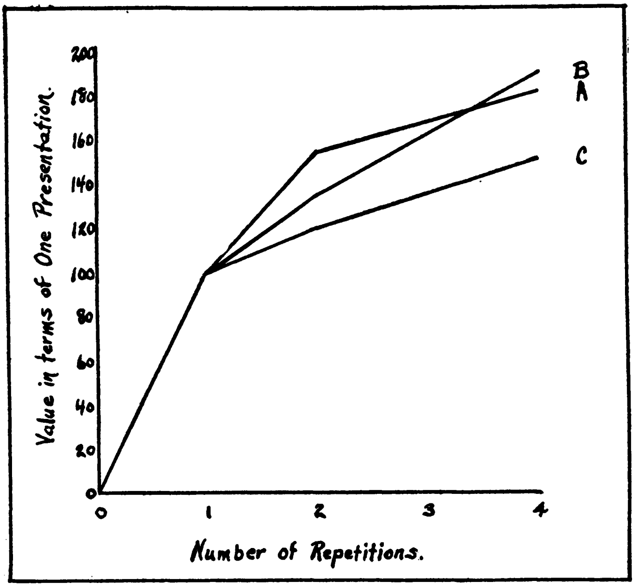

PLATE I. Showing the *Increase* in Effect of Seeing Two Advertisements or Four Advertisements over that of Seeing One Advertisement when (*a*) the Advertisements Follow One Another at Intervals of a Few Minutes, (*b*) the Advertisements Follow at Intervals of One Week, and (*c*) the Advertisements Follow at Intervals of One Month.

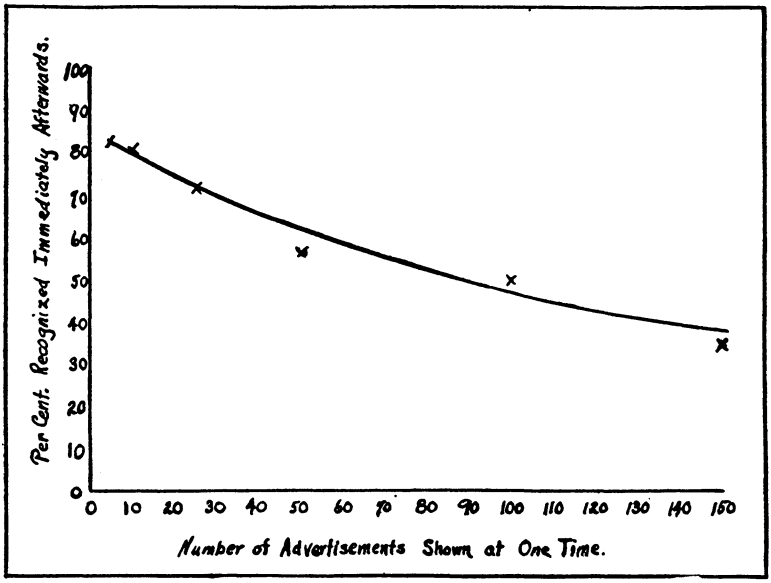

PLATE II. Showing the Decrease in the Number of Advertisements that can be Recognized Immediately Afterwards as the Total Number of Advertisements Shown at One Time is Increased.

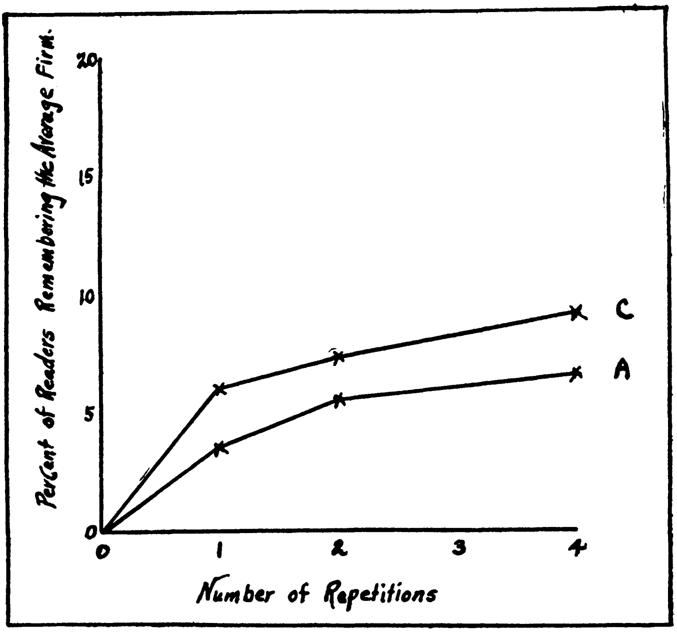

PLATE III. Showing the Per cent. of Readers who Remember a Firm Four Months after the First Advertisement is Seen when, (*a*) the Advertisements Follow One Another at Intervals of a Few Minutes and 168 Pages of Advertising are Seen All at One Time, and (*b*) the Advertisements Follow at Intervals of One Month and but 42 Pages of Advertising are Seen at One Time.

I have already shown that as you increase the number of advertisements that are seen at any one time, you correspondingly decrease the total number that may be recognized immediately afterwards.[7] In other words, this means that the larger the number of objects attended to at one time the smaller can be the impression from any one of them. The curve is shown in Plate II. Now this law holds true in advertising, as I have sufficiently shown in some experiments done for practical advertising men. For example, the average full-page advertisement in *Everybody's Magazine* with its 144 pages of advertising is remembered by 6.8 per cent. of the readers, whereas such an advertisement in the *National Geographic Magazine* with but 24 pages of advertising is remembered by 12.4 per cent. of its readers. In both these cases the persons tested read the magazines at their leisure and were tested one week after—none of them ever dreaming that he would be tested. The advertisements in the smaller advertising section, where but 24 pages of advertising were to be seen, were remembered by 84 per cent. more individuals than in the larger magazine with its 144 pages of advertising. From our curve we find that one advertisement in 24 can be remembered by 73.5 per cent. of the subjects immediately afterwards as compared with but 38.0 per cent. when 144 advertisements are seen all at once. In this case the superiority is 94 per cent. A difference of but 10 per cent. between these two investigations, widely different in character as they are, is of no great moment.

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[7] E. K. Strong, Jr., "The Effect of Length of Series upon Recognition Memory," *Psychol. Rev.*, 1912, 19, pages 447–462.

Let me give you another example. Recently I tested two groups of individuals—one group looked through a magazine containing 42 advertising pages, the other looked through this same magazine and 3 others with a total of 168 pages of advertising. One month later they were tested as to the advertisements they noticed. The second group remembered 7.8 per cent. of the advertisements in the first magazine, whereas the first, who saw only one magazine, remembered 14.9 per cent. of the advertisements in it. Increasing the number of advertising pages from 42 to 168 resulted in a decrease in the per cent. remembered among the 42 pages from 14.9 per cent. to 7.8 per cent. That means that the situation in which but 42 pages are read allows a 91 per cent. greater impression to be made than the one in which 168 pages are read. Now what do we find from our curve (Plate II.)? The superiority of 42 pages is just 95 per cent. greater than 168 pages. Here the difference between these two entirely different experiments is but 4 per cent. Let me emphasize this. In the experiment on which was based the curve in Plate II. the individuals were allowed but one second a page and were tested immediately afterwards. In the just mentioned experiment the individuals were allowed to look at the magazines as they ordinarily do, spending as much time as they wished to. And here they were tested one month afterwards. Yet in both cases the relative superiority of the impression made from each one of 42 pages of advertising over that of each one of 168 pages was practically identical—being, respectively, 95 per cent. and 91 per cent.

I think there is no doubt I have proved my point—that the smaller the number of objects attended to at one time the greater the impression each can and does make.

Here it seems to me my results parallel those of Pyle to a considerable degree. After a certain length of time he finds that further increases of time do not give corresponding increases in amount learned. In his work other factors, such as "warming-up," etc., may be present to prevent the shorter time intervals from being so effective as intervals which are a little longer. My work certainly shows that the fewer advertisements seen at once the better chance each has to be remembered.

But why is this so? I feel myself that an answer may be found to this query by a scrutiny of some work along a rather different line.

Müller and Pilzecker first emphasized the fact that, in memorizing, the best results could be obtained by resting after learning instead of going on to other work. When a second stanza was learned immediately after the first, the retention of the first was injured to a considerable degree as compared with the case where an interval of rest was allowed before the study of a second stanza. For example, a score of 56 was thus lowered to 26. This inhibitory effect has been referred to by the term "retroactive inhibition." Book told me a few days ago of some work he had just finished. He found that nonsense syllables were best retained if a short period of rest followed the memorizing. If a problem in arithmetic followed the memorizing, the syllables could not be remembered so well as if the memorizer had rested instead, but they could be remembered better than if a second series of syllables were studied during that period.

It is apparent from these studies that strenuous mental work following immediately a mental process of learning acts in an inhibitory manner upon the already formed associations. Possibly, indeed, we should speak of such associations, not as formed, but still forming. For apparently we must look upon the learning process as a formation of new associations which require some time in which to "set" or become "consolidated." Immediate subsequent activity seems to inhibit such consolidation. Moreover, the more similar the subsequent activity is to that which has gone before, the more serious is the injury to the earlier work.

With this in mind it is very easy to see a good reason for the results I have been obtaining in my work in advertising. The impression from the first advertisement seen in a magazine requires some time in which to set. But the impression made from the second advertisement follows it immediately and inhibits the first. A third impression follows and inhibits further the first two, and so on. And so we find that the more advertisements seen at any one time the slighter the permanent impression from any one of them.

Coming back now to the work of Starch and Pyle, we must see in their work the same situation that has faced us in advertising. In learning of any sort the more new impressions made one after the other, the less can be the permanent retention from any one of them. And this is the reason that Pyle can find the surprising fact that an individual can actually learn more working 30 minutes a day than when working 60 minutes a day.

To return to the results of my own investigations. I have one more point to bring out. I have shown that intervals of different lengths between repetitions are of different values, and that the greater the number of impressions received at any one time the less permanent any one of them can be. Now of these two factors in the learning process the second is by far the more important.

By combining the results of two experiments we have this situation. One group of individuals saw four magazines one right after the other. The other group saw the same four magazines at intervals of one month. Both groups were tested four months after the first magazine was seen in each case. Plate III. shows the results. It is very evident that the second arrangement is better than the first. Now we have already seen that repetitions separated by a few minutes are very much more effective than repetitions a month apart. The trouble here is that the first group saw 168 pages of advertising at one time, whereas the second group saw only 42 pages of advertising at any one time. The slight impression possible from any one advertisement among 168, as compared with the impression received when among 42 advertisements, has far offset the advantage from having the repetitions within a few minutes as compared with one month.

Summarizing, I have hoped to make clear in this paper:

First. Of all intervals between successive repetitions that of a day's length will give us our maximum results, and those of a few minutes and of a week are much superior to that of a month.

Second. The more impressions made at one time, the less is the permanent retention of any one of them. This is probably due to the effect of retroactive inhibition.

Third. In any situation when both length of interval and the number of impressions to be made at any one time are concerned, it should be borne in mind that the second factor is far more important than the first.

This means that further work should be directed more particularly to a better understanding of how many impressions can be made to advantage at any one time, rather than to the proper interval of time between their successive presentations.

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CONCEPTS AND EXISTENCE

PROFESSOR BUSH'S discussion on "Concepts and Existence"[1] provokes me to violent agreement with every point he there makes, save one. And that one is, I believe, not at all vital to Professor Bush's central thesis. It is, however, important enough to be cleared up. For upon it alone Professor Bush rests his argument

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[1] This JOURNAL, Vol. X., page 686.